***Key Issues:***
**9-Public Health**

***Climate Zone:***
Sub-tropical to Temperate

***Subjects:***
- Steps leading to improvement in Public Health and Infrastructure

***Effect:***
- Improvement in health facilities
- Improvement in general infrastructure
- Socio-economic improvement

***Project Name:*** Chamera Hydroelectric Project Stage-I (540 MW)
***Country:*** The State of Himachal Pradesh, India (Himachal Pradesh)

***Implementing Party & Period***
***- Project:*** National Hydroelectric Power Corporation Ltd. (NHPC)
1985 (Commencement of Construction) -
***- Good Practice:*** National Hydroelectric Power Corporation Ltd. (NHPC)
19?? (R&R Plan Prepared) - 19?? (R&R Plan Completed)

***Key Words:***
Public Health, Infrastructure improvement, Socio-economic Development

***Abstract:***
The 540 MW Chamera Hydroelectric Project Stage-I is one of the largest projects in the region constructed by National Hydroelectric Power Corporation Ltd. The construction of the project which lead to huge investment in the area not only served the power demand in the region but also accrued with it number of benefits to the local population in terms of basic infrastructure like health facilities, communication, education facilities besides other socio-economic benefits to the area like generation of employment and business opportunities.

## 1. Outline of the Project

Chamera Hydroelectric Project Stage-I is located on river Ravi in the State of Himachal Pradesh, India. The state is mainly mountainous with a number of perennial streams and rivers like Ravi, Satluj and Beas etc. forming the drainage system. Ravi, on which the project is located, is a perennial snow fed river. It has an identified power potential of 2365 MW out of which about 57 % i.e. 1342 MW (including 540 MW of Chamera Stage-I) has been harnessed so far and another 300 MW Chamera Stage-II project is being implemented by NHPC. Field investigations for the project were done with collaboration from Canada and completed in a record time of 8 months by using modern techniques. Actual construction work of the project commenced in 1985 and the project was commissioned in March' 1994.

Chamera HE Project Stage-I is run-of-the-river scheme located in district Chamba of Himachal Pradesh. The project comprises a "Concrete Arch Gravity Type" Dam of height 141 m from the deepest foundation level, 9.5 m dia. and 6.44 km long HRT , 84 m high surge shaft and 157 m long vertical pressure shaft connecting to an underground Power House through 3 no circular penstocks. The reservoir behind the Dam extends to 18 km upstream of river Ravi and 11 km along the river Siul. The surface area of the reservoir is approximately 9.5 sq. km. The project has an installed capacity of 540 MW (3X180 MW) and has already generated a total of 20190 million units till June'03 since its commissioning in 1994 against the cumulative target of 16084 million units and is proving to be a great boon for the Northern Region of India by providing reliable and peak power.

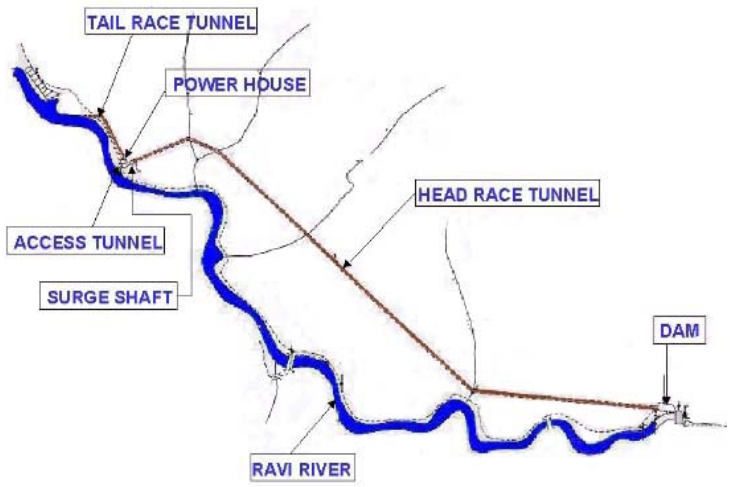


Fig.2 Layout Plan of Chamera HE Project

Table 1 Specifications of Chamera HE Project Stage-I

| SALIENT FEATURES | |
|---|---|
| **Location** | Dist. Chamba, Himachal Pradesh |
| **Approach** | Nearest Rail Head Pathankot |
| **Capacity** | 540 MW (3 x 180 MW) |
| **Annual Generation** | 1664 million units |
| **Project Cost** | Rs. 21140.02 million, (March'94 price level ) |
| **Beneficiary States** | H.P., Punjab, Haryana, Delhi, J&K, Rajasthan, U.P. & Chandigarh |
| **Tariff rate** | 211.20 Paise / Unit |
| **Year of Commissioning** | 1994 |
| **TECHNICAL FEATURES** | |
| 140 m high, 295 m long concrete arch gravity dam. | |
| 6.4 km long, 9.5 m dia. head race tunnel. | |
| 2.4 km long, 9.5 m dia. tailrace tunnel. | |
| Underground Power House containing 3 units of 180 MW each. | |

## 2. Features of the Project Area

The project under study falls in Ravi basin in the State of Himachal Pradesh in India. The basin has a vast potential for water resources development and less than 60 percent has been tapped during the past five decades of planned development. The valley is rich in forest wealth and biodiversity. Unlike other major rivers of North India, no natural lake feed this river. The river passes through famous Chamba valley, which is known for its scenic beauty and grandeur of Himalayan ranges. Ravi is the major river of Indus basin originating in Himalayas from Bara Bhangal, a branch of Dhauldhar with snow covered ranges from EL 3050 M to EL 5800 M above mean sea level. In its circuitous run of 728 km, the river flows Northwesterly having en route a series of narrow gorges alternating with open wide valleys with steep slopes. After reaching the plains it crosses the international boundary into Pakistan about 26 km from Amritsar.

Fig.3 Chamba Valley

The project is connected to the nearest railhead Pathankot by 101 km road. The Power House is situated at Khairi and Dam is located at Chaura, which is 22 km from Banikhet. The Dam is linked to Power House by 16 km long road on the right bank of river Ravi.

The project area is in the lower part of the Himalayas and has Sub tropical Dry Evergreen forests below EL 1050 m, Himalayan Sub tropical Pine Forests between EL 1050m to 1600 m and Lower Western Himalayan Temperate Forests above EL 1600 m. The main species of trees found in the area are Pinus rox-burghii, Cedrus deodara, Pyrus sp, Aesculus indica, Rhododendron arboreum, Albizia stipula, Quercus-incana, Alnus nitida etc.

The general climate of the region is sub-tropical to temperate depending on elevation. The upper reaches around Banikhet, Bathri, Sukaini galla and Sikri Dhar receive a fair amount of precipitation as snow during winter i.e. December to March. The months of April to July span the summer season where after the monsoons arrive lasting up to September. The relative humidity is generally high during monsoon and low during post monsoon and winter season. The average mean annual rainfall is 2230 mm. The mean Daily maximum and minimum temperature at Chamba during the months is as per the table below:

Table 2 Mean Daily Maximum and Minimum Temperature at Chamba

| Nos. | Duration | Mean Daily max. temp | Mean Daily min. temp. |
|---|---|---|---|
| 1. | January to March | 15.2 $^{o}$C to 22.3 $^{o}$C | 5.2 $^{o}$C to 10.6 $^{o}$C |
| 2. | April to June | 28.6 $^{o}$C to 30.4 $^{o}$C | 14.6 $^{o}$ C to 22 $^{o}$C |
| 3. | July to September | 30.4 $^{o}$C to 29.1 $^{o}$C | 22 $^{o}$C to 18.1 $^{o}$C |
| 4. | October to December | 27.1 $^{o}$C to 28.3 $^{o}$C | 12.6$^{o}$C to 5.9 $^{o}$C |

The project lies in so called lesser Himalayas consisting of pre-tertiary, poorly fossilferous rocks that have been folded, thrust and metamorphosed into a Complex structure. The project area is occupied by a gamut of rock types comprising granite gneiss, granite, phylitic quartzite slates, limestone, carbonaceous phyllite, quartzite and volcanic ranging in age from Precambrian to upper Tertiary. The entire sequence is highly folded and faulted. Two major regional thrusts are exposed within the project area, namely jutogh thrust and Shali thrust. The project lies in a highly seismic belt and falls within seismic Zone V of the seismic Zoning map of India sub continent.

## 3. Major Impacts

People living in and around the project area needed resettlement due to submergence of land because of construction of project. The total number of families affected due to acquisition of land for project construction was 1554 out of which 433 families became houseless or landless and needed resettlement. Rest of the families were affected partially only (losing part of land etc.). Besides this there were other environmental Impacts like submergence, deforestation, loss of flora/fauna, soil erosion etc. All the above impacts were however compensated by taking comprehensive mitigation measures.

## 4. Mitigation Measures

Various mitigation measures were taken by NHPC to nullify the affects due to construction of project and to improve the overall socio-economic environment in the area. Environment considerations were incorporated right from the planning stage and were implemented during the construction of project. The benefits extended to the locals in the form of mitigation measures are as per below:

**a. Rehabilitation of Land Oustees**- Rehabilitation of land oustees was done through State Government and the cost of it was borne by NHPC. Apart from compensating in full for their land, houses, trees & other immovable properties, the oustees have also been paid compensation @ Rs 45000 per homeless family and Rs 20000 per landless family.

**b. Construction/widening of Roads**- The 80 km long Chamba-Banikhet-Pathankot road which used to be single lane road causing frequent traffic jams was got widened and converted into two lane which has now become lifeline for accelerated tourist inflow to Dalhousie. The construction of 22 km long Bagdhar to Khairi road which traverses through 16 adjoining villages and 37 km road from Goli to Dam site to Khairi linking various other villages in the periphery of project made the life of the inhabitants much easier. Apart from this, 5 no bridges at a capital cost of Rs 32.6 millions were got constructed in the area by NHPC.

Fig.4 Medical aid at project hospital

**c. Health Care Services**- Two hospitals, one at Banikhet and one at Khairi along with Project Dispensary at Sundla and first aid post at Dam site have been established by NHPC for providing medical services to its employees and local inhabitants. Various medical Camps have

also been organized in the area for the purpose of providing medical services to the local inhabitants at their door-step without any cost. Medicines are also provided to the people free of cost. The budget for medical services and hospitals is about Rs 3.1 millions per annum. Also medical facilities to the tune of Rs 3 million (approx) have so far been extended to the locals by NHPC.

**d. Education facilities-** Two Kendriya Vidyalaya schools one at Banikhet (upto $10^{th}$ Standard) and one at Khairi (upto $12^{th}$ standard) along with one Nursery K.G. School have been established/opened by NHPC with a view to provide better educational facilities. The wards of local inhabitants are also availing educational facilities in these schools. Apart from this, NHPC has also been providing grant/aid to other schools/educational institutions operating in the area for their better maintenance and operation**.**

Fig.5 School Laboratory

**e. Banking and Postal facilities-** Prior to start of project, the nearest post office and bank available for Khairi residents were 16 km and 30 km away respectively. After the start of project, a branch of State Bank of India (SBI) was got opened in Khairi by NHPC in 1987. Then a Post Office was also got established to improve the communication with the outside areas. The SBI branch at Khairi now does a transaction of Rs 9 millions per month and provides services to as many as 22 villages scattered around the vicinity of the project.

**f. Security Services-** In order to maintain the law and order in the area, a Police Station has been got established at Khairi and the cost of it is being borne by NHPC. Central Industrial Security Force (CISF) having a total manpower of 160 headed by a Dy. Commandant is engaged in fulfilling the security requirements in the project area. The accommodation and other recreational & essential services to CISF personnel are being provided by NHPC.

**g. Employment/Business opportunities-** The project has generated employment/earning opportunities for the local people. There are more than 20 contractors from the local area who by doing project work, have now grown into major contractors. The infrastructure for the market has also been provided by the project, facilitating establishment of shops. Besides this, 700 people were provided employment in the project.

**h. Tourism development-** With the persuasion of NHPC, Tourism Department, State Government is taking up establishment of tourist facilities including boating arrangements in the Chamera Dam reservoir which has potential for water sports activities. It would provide added charm to the tourists visiting the area and will boost income from tourism to the State Government as well as local people.

**i. Aquaculture Development-** The project has extended Chamera reservoir facility to the Fisheries Department for development of aquaculture and a fish farm was constructed at Sultanpur in Chamba, which has tremendously helped in generating additional employment & revenue. Besides this NHPC

has released Rs 3 million towards rehabilitation of "Lift Irrigation Scheme" and Rs 0.5 million towards rehabilitation of water supply in the area to serve the basic interests of the local inhabitants.

**j. Establishment of Spiritual Center and Gym/Health Center-** A spiritual Center has been established in the area to provide the much needed moral/spiritual/ethical upliftment opportunities to the members. A Gym/ Health center has also been established and Yoga classes are also held for physical fitness.

**k. Compensatory Afforestation-** Construction of Chamera project involved 982.7 ha of forestland with about 4000 trees**.** As a measure of environment protection, massive Compensatory afforestation was taken up and 4.58 million saplings were planted by NHPC at a cost of Rs 38 millions in 2000 ha in lieu of 982.5 ha of forest land which was lost on account of the project construction.

Fig.6 Afforestation at Chamera-I

## 5. Results of the Mitigation Measures

**a. Resettlement of displaced people**

The cash compensation provided by NHPC under the Rehabilitation plan enabled the Project Affected People to construct new houses at the relocated places. All basic amenities in terms of infrastructure, medical facilities, schools developed by NHPC were extended to the Project Affected People (PAP) that resulted in better lifestyle there.

**b. Improvement in public health**

The construction of hospitals along with project dispensary in the area has helped a long way in providing much needed medical aid to the local inhabitants. Moreover the regular medical Camps being organized by NHPC in the surrounding villages and distribution of free medicines have improved the general health of the locals and has drastically reduced the number of deaths in the area due to epidemic etc. The above is clear from the graph which indicated that the number of male and female deaths due to epidemics have reduced from 495 and 389 respectively in 1985 (i.e. prior to start of construction of project) to zero in 1993. The number of Inhabitated villages having availability of Potable water has also increased.

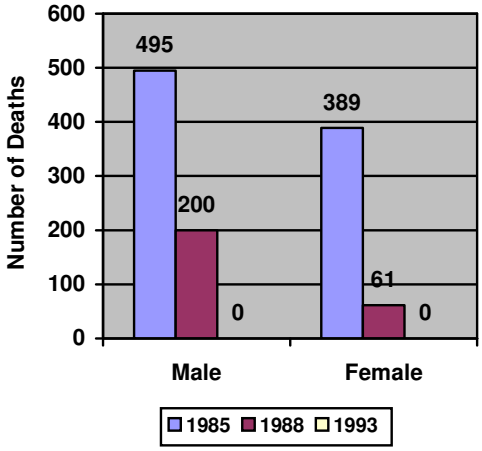


Fig.7 Decrease in deaths from epidemics

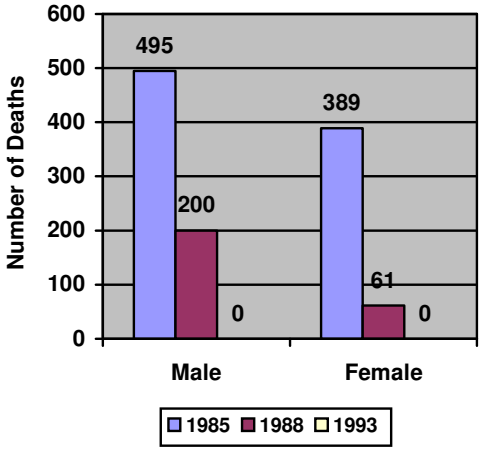


Fig.8 Increase in potable water supply to village inhabitants

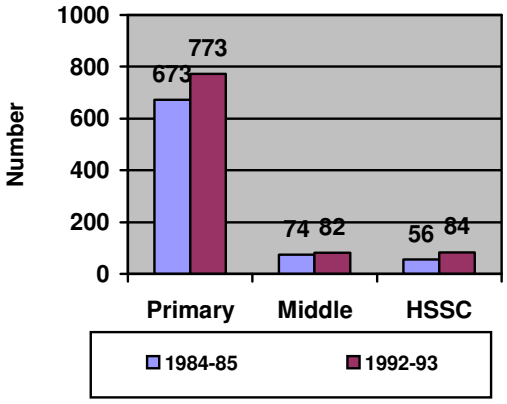


Fig.9 Increase in number of educational institutes

**c. Improvement in education**

Prior to start of construction of Chamera Project, there used to be only one higher secondary school in the area to cater to the educational needs local population. The construction of new schools and provision of aid/grant to other schools operating in the nearby area by NHPC has enabled the wards of local inhabitants to avail the educational facility which has resulted in improving the literacy in the area. With the coming up of Chamera project the number of primary, Middle and Higher secondary schools in the area have increased appreciably and is shown in the graph:

**d. Better infrastructure and communication with other areas**

Many villages in the area before the construction of Chamera Project were cut off with the main town in the absence of any road network. The construction of new roads and bridges in the area lead to linking of various villages in the periphery of the project and has made the lives of inhabitants of these villages much easier. Massive infrastructure development activities took place in the area with the start of construction of project. Many new Factories, hospitals, educational Institutes and other development activities in the area added new pace to the life of local population.

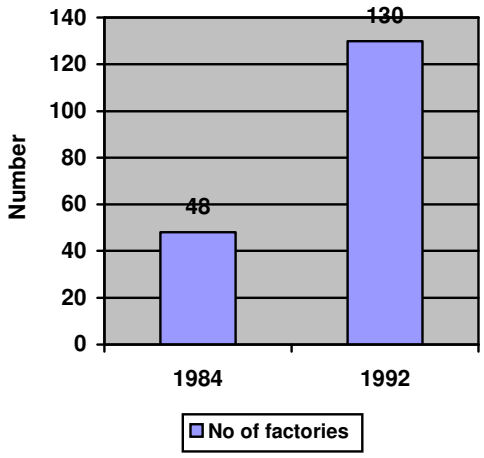


Fig.10 Increase in number of factories

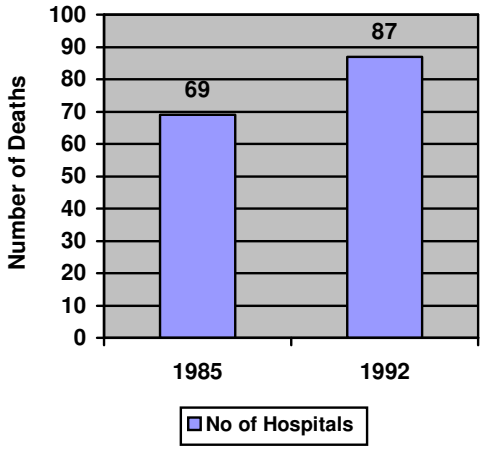


Fig.11 Increase in number of hospitals

**e. Socio-economic development**

The construction of Chamera HE Project has been a major development activity in the area during year 1984- 1994. Many other development activities have also taken place in the area due to construction of the project and there has been considerable upliftment in the socio-economic conditions of the local population. Employment generation took place in the area through NHPC as well as through its contractors directly or indirectly. The availability of reliable electricity supply with the construction of project has helped in creation of new industries in the area and facilitated tourism. The fish farm constructed in collaboration with the State fisheries department in Chamba increased the fish production in the area. The additional benefits to the local population is clearly evident from the development indicators such as literacy, educational institutes, number of industries, mineral production, availability of potable water, health aspects and so on. A socio-economic survey conducted for the families who were provided with employment with the Chamera project has also revealed that they have settled well and enjoying better social status than before the construction of project.

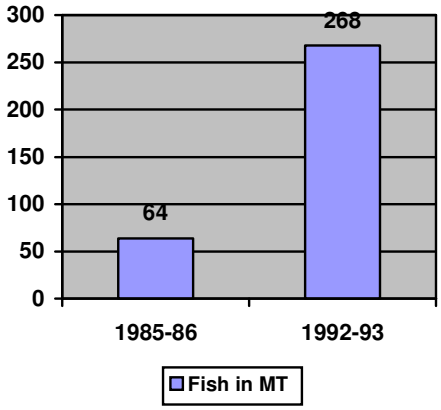


Fig.12 Increase in fish production (Chamba District)

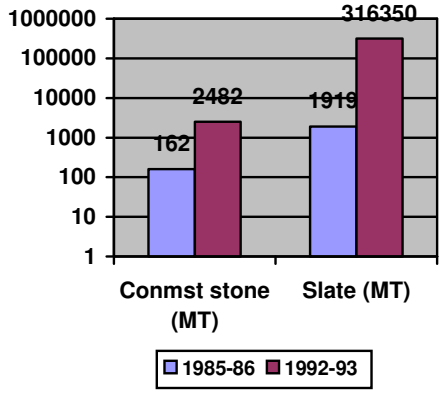


Fig.13 Increase in mineral production

**f. Summary**

Various mitigation measures taken by NHPC to minimize the effect of project construction and for improvement of infrastructure, public health and other amenities to the local population can be tabulated as below:

| Nos. | Mitigation Measure | Result |
|---|---|---|
| 1 | Rehabilitation of oustees | Minimized the affect of displacement and cash compensation helped the displaced people in construction of houses at new places |
| 2 | Construction of schools | Helped in imparting education to the children and improving the literacy in the area |
| 3 | Construction/widening of roads/bridges | Better connectivity of local villages with main town thus facilitating fast transit and boosting tourism. |
| 4 | Health care facilities | Improvement in general public health in the area and reduction in number of deaths due to epidemics. |
| 5 | Employment to oustees | Reduction of unemployment and economic development of people |
| 6 | Banking and postal facilities | Improved communication with outside areas and financial transaction facilities. |
| 6 | Tourism development | Increasing the business avenues due to tourist inflow for local population thus improving the economic condition. |
| 7 | Aquaculture development | Employment opportunities to the locals. |
| 8 | Spiritual Center and Gym/Health care center | Moral/spiritual/ethical upliftment and improvement in physical fitness of its members. |
| 9 | Compensatory Forestation | Environment protection of the area. |

The positive trend shown by the various development indicators as mentioned above clearly indicates that the construction of Chamera project has significantly contributed in giving a boost to overall development in the area. The massive infrastructure development in the area, has led to socio-economic development and improvement in general public health of the local population.

## 6. Reasons for Success

In case of Chamera HE Project the various surveys on affect of environment, public health, literacy, socio-economic condition of locals etc. conducted by NHPC after the completion of project indicates that the mitigation measures taken by NHPC have shown positive results and the improvement made in above fields is much more than damage caused. The success of the effort is largely due to timely and adequate planning and implementation of various mitigation measures, supplemented by a very stringent monitoring mechanism which yielded desired results. The main reasons for the success in brief can be taken as per below:

a. Formulation of R&R Plan with approval of State Government.
b. Public participation in resettlement program
c. Support of Local Administration and State Government
d. NHPC's belief in concept of sustainable development and commitment towards discharging its responsibilities in upliftment of society.

## 7. Outside Comments

Chamera HE Project was awarded with "Indo-German GREENTECH Environment Excellence Award" in year 2001 by Green Tech Foundations, New Delhi. The award was given in the field of

'Management of Water Environment, Biological Environment, Mitigation measures, Afforestation and Construction of Fish farm'.

## 8. Further Information

### 8.1 References

1) Chamera Stage-I Booklet by NHPC Ltd
2) Indian Journal on Power and River valley development, May-June, 1994.
3) Report on Socio development in Chamba by NHPC.
4) Collection of data from published papers and other sources

### 8.2 Inquiries

National Hydroelectric Power Corporation Ltd.
Sector-33
Faridabad-121003 (Haryana)
INDIA.
E-mail: amitgupta@nhpc.nic.in